



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
ENVIRONMENTAL RESPONSE TEAM - WEST  
4220 S. MARYLAND PARKWAY  
BUILDING D, SUITE 800  
LAS VEGAS, NEVADA 89119



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MEMORANDUM

SUBJECT: Indoor Worker Scenario PRG run using Release Criteria

FROM: Lyndsey Nguyen  
Health Physicist, Environmental Response Team-West (ERT-W)

TO: File for Hunter's Point Naval Shipyard (HPNS)  
Attn: Lily Lee, Remedial Project Manager (RPM), Region 9

The Preliminary Remediation Goal (PRG) calculation for an indoor worker scenario is described as the following:

“This receptor spends most, if not all, of the workday indoors. Thus, an indoor worker has no direct contact with outdoor soils. This worker may, however, be exposed to contaminants through ingestion of contaminated soils that have been incorporated into indoor dust, external radiation from contaminants in soil, and the inhalation of contaminants present in indoor air. PRGs calculated for this receptor are expected to be protective of both workers engaged in low intensity activities such as office work and those engaged in more strenuous activity (e.g., factory or warehouse workers).”

There are two gamma shielding factors included with the indoor worker scenario. Attachment B shows a picture to describe each of the various gamma shielding factors used throughout the PRG calculators. The first gamma shielding factor is called the indoor gamma shielding factors,  $GSF_i$ , which accounts for the shielding of the foundation. The  $GSF_i$  is set to 0.4. The next gamma shielding factors is called the Clean Soil Thickness. This is a thickness in centimeter depth and not a factor; however, the acronym is still  $GSF_b$  which looks like it would be a factor rather than a depth. The  $GSF_b$  is the clean soil depth that is underneath the foundation.

For both  $GSF_i$  and  $GSF_b$ , these values only influence the external gamma to the receptor. The  $GSF_i$  and  $GSF_b$  do not influence the risk to the receptors nor the PRG values for radionuclides via inhalation nor ingestion. As described earlier, the default assumption for the indoor worker scenario, is that the indoor worker ingests contaminated soils and inhales contaminants present in indoor air. This assumes no cap nor clean cover outside. To account for a clean cover, the soil intake and inhalation rate must be equal to

zero. For Hunter's Point Naval Shipyard (HPNS), a clean cover of 20cm at a minimum is used for outdoor surfaces. Therefore, the values for inhalation and ingestion should be equal to zero.

Using the release criteria in Attachment A, the following assumptions were made for the indoor worker scenario were:

Exposure Duration = 25 years

Exposure frequency = 250 days/year

Exposure time = 8 hours/day

Soil Intake = 0 mg/day

Inhalation Rate = 0 m<sup>3</sup>/day

Area Correction Factor (ACF) = 1000000 (to mimic infinite plane geometry)

Indoor Gamma Shielding Factor (GSF<sub>i</sub>) = 0.4 (this accounts for the foundation shielding only)

Clean Soil Thickness (GSF<sub>b</sub>) = 0cm (this assumes that the residual contamination is directly in contact with the foundation)

Vegetation Factor = 0.5

Acres = 420

The results from the risk assessment of the RGs with the site specific parameters for indoor worker at HPNS seen in Attachment C, as well as the PRG values for the indoor worker scenario for soil.

# Attachment A

## Release Criteria

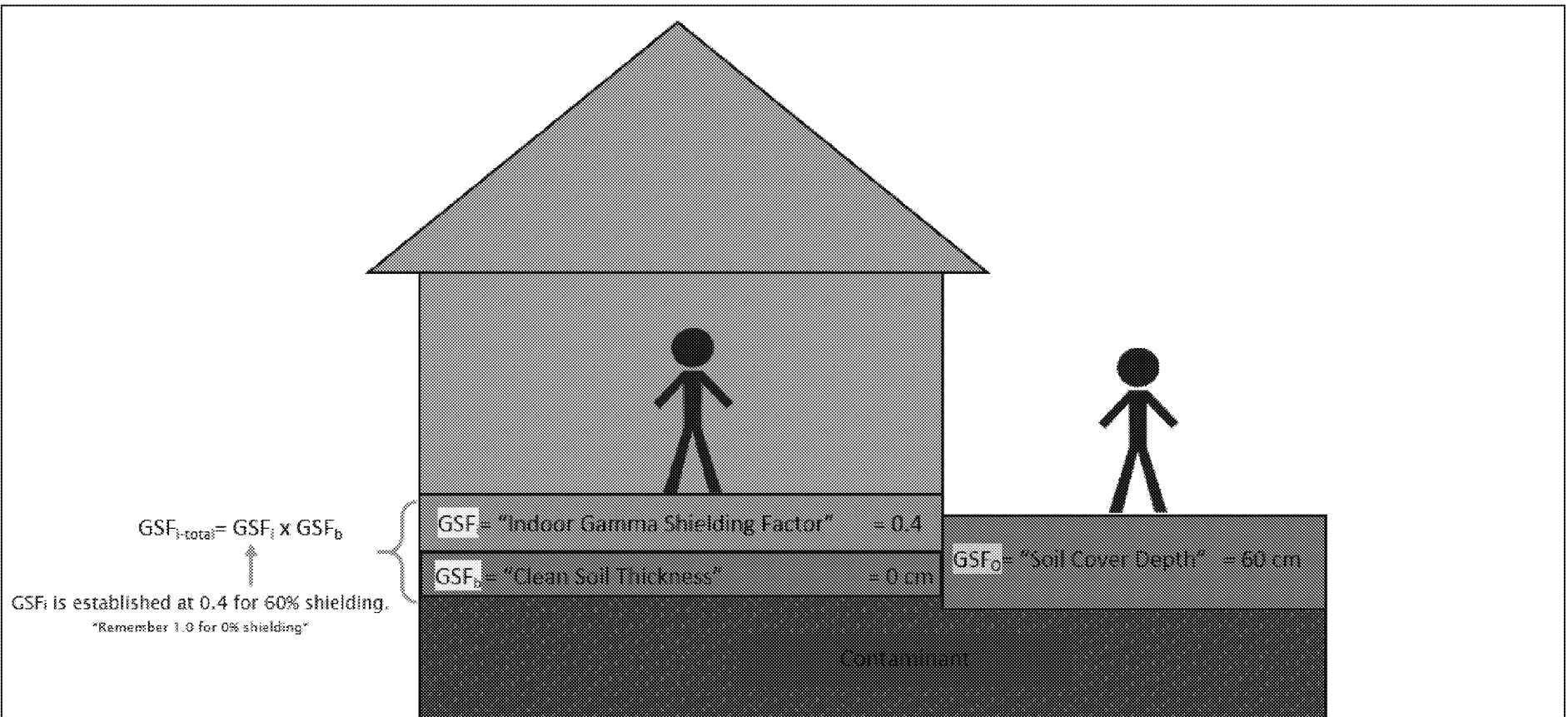
Radionuclide	Surfaces			Soil <sup>d</sup> (pCi/g)				Water <sup>h</sup> (pCi/L)
	Equipment, Waste (dpm/100 cm <sup>2</sup> ) <sup>a</sup>	Structures (dpm/100 cm <sup>2</sup> ) <sup>b</sup>	Residual Dose (mrem/yr) <sup>c</sup>	Outdoor Worker (pCi/g) <sup>d</sup>	Residual Dose (mrem/yr) <sup>c</sup>	Residential (pCi/g) <sup>e</sup>	Residual Dose (mrem/yr) <sup>c</sup>	
Americium-241	100	100	18.7	5.67	0.8661	1.36	24.84	15
Cesium-137	5,000	5,000	1.72	0.113	0.2142	0.113	0.2561	119
Cobalt-60	5,000	5,000	6.01	0.0602	0.5164	0.0361	0.3918	100
Europium-152	5,000	5,000	3.21	0.13 <sup>f</sup>	0.5018	0.13 <sup>f</sup>	0.502	60
Europium-154	5,000	5,000	3.49	0.23 <sup>f</sup>	0.9593	0.23 <sup>f</sup>	0.9599	200
Plutonium-239	100	100	18.1	14.0	1.743	2.59	1.138	15
Radium-226	100	100	0.612	1.0 <sup>g</sup>	6.342	1.0 <sup>g</sup>	14.59	5 <sup>i</sup>
Strontium-90	1,000	1,000	0.685	10.8	0.1931	0.331	1.648	8
Thorium-232	1,000	36.5	24.9	2.7	24.91	1.07 <sup>f</sup> 1.69	25	15
Tritium	5,000	5,000	0.00053	4.23	0.00179	2.28	0.05263	20,000
Uranium-235+D	5,000	488	25	0.398	0.178	0.195	0.8453	30

### Notes:

- <sup>a</sup> These limits are based on AEC *Regulatory Guide 1.86* (1974). Limits for removable surface activity are 20 percent of these values. Risk is 10<sup>-4</sup> @ 25 mrem/yr.
- <sup>b</sup> These limits are based on 25 mrem/yr, using RESRAD-Build Version 3.3 or *Regulatory Guide 1.86*, whichever is lower.
- <sup>c</sup> The resulting dose is based on modeling using RESRAD-Build Version 3.3 or RESRAD Version 6.3, with radon pathways turned off.
- <sup>d</sup> EPA PRGs for two future-use scenarios.
- <sup>e</sup> The on-site and off-site laboratory will ensure that the MDA meets the listed release criteria by increasing sample size or counting time as necessary. The MDA is defined as the lowest net response level, in counts, that can be seen with a fixed level of certainty, customarily 95 percent. The MDA is calculated per sample by considering background counts, amount of sample used, and counting time.

## Attachment B

Picture to Describe Various Gamma Shielding Factors Used in the PRG Calculations



GSF<sub>i</sub> is the shielding factor of contaminated soil from the structure/house, while the person is inside the structure/house. This usually accounts for foundation of the building (default value of 0.4)

GSF<sub>o</sub> is the depth of clean soil sitting on top of contaminated soil, while the person is outside the structure/house.

GSF<sub>b</sub> is the depth of clean soil underneath the foundation sitting on top of contaminated soil, while the person is inside the structure/house

The yellow highlighted values go into the PRG calculator directly for indoor worker scenario.

The yellow and green highlighted values together go into the PRG calculator directly for residential scenario.

## Attachment C

PRG Output for indoor worker at HPNS Release Criteria

### Site-Specific Indoor Worker Equation Inputs for Soil - Secular Equilibrium

Variable	Value
Site area for ACF (area correction factor) $m^{-2}$	1000029
TR (target cancer risk) unitless	0.0001
$t_w$ (time - indoor worker) yr	25
$EF_w$ (exposure frequency - indoor worker) day/yr	250
$ED_w$ (exposure duration - indoor worker) yr	25
$IRS_w$ (soil intake rate - indoor worker) mg/day	0
$IRA_w$ (inhalation rate - indoor worker) $m^{-3}$ /day	0
$ET_w$ (exposure time - indoor worker) hr/day	8
$GSF_i$ (indoor gamma shielding factor) unitless	0.4
City (Climate Zone)	26
$A_i$ (acres)	420
$Q/C_{wp}$ ( $g/m^2 \cdot s$ per $kg/m^3$ )	32.359832679927
PEF (particulate emission factor) $m^{-3}/kg$	4078965031.9716
A (PEF Dispersion Constant)	13.8139
B (PEF Dispersion Constant)	20.1624
C (PEF Dispersion Constant)	234.2869
$V$ (fraction of vegetative cover) unitless	0.5
$U_w$ (mean annual wind speed) m/s	3.89
$U_i$ (equivalent threshold value)	11.32
$F(x)$ (function dependant on $U_w/U_i$ ) unitless	0.0391

## Site-Specific Indoor Worker PRGs for Soil - Secular Equilibrium

Isotope	Ingestion PRG TR=0.0001 (pCi/g)	Inhalation PRG TR=0.0001 (pCi/g)	External Exposure PRG TR=0.0001 (pCi/g)	Total PRG TR=0.0001 (pCi/g)
<i>*Secular Equilibrium PRG for Am-241</i>	-	-	2.17E+01	<b>2.17E+01</b>
<i>*Secular Equilibrium PRG for Co-60</i>	-	-	3.54E+00	<b>3.54E+00</b>
<i>*Secular Equilibrium PRG for Cs-137</i>	-	-	1.73E+01	<b>1.73E+01</b>
<i>*Secular Equilibrium PRG for Eu-152</i>	-	-	8.10E+00	<b>8.10E+00</b>
<i>*Secular Equilibrium PRG for Eu-154</i>	-	-	7.49E+00	<b>7.49E+00</b>
<i>*Secular Equilibrium PRG for H-3</i>	-	-	-	-
<i>*Secular Equilibrium PRG for Pu-239</i>	-	-	1.88E+01	<b>1.88E+01</b>
<i>*Secular Equilibrium PRG for Ra-226</i>	-	-	5.23E+00	<b>5.23E+00</b>
<i>*Secular Equilibrium PRG for Sr-90</i>	-	-	2.25E+03	<b>2.25E+03</b>
<i>*Secular Equilibrium PRG for Th-232</i>	-	-	3.85E+00	<b>3.85E+00</b>
<i>*Secular Equilibrium PRG for U-235</i>	-	-	1.88E+01	<b>1.88E+01</b>

## Site-Specific Indoor Worker Risk for Soil - Secular Equilibrium

Isotope	Ingestion Risk	Inhalation Risk	External Exposure Risk	Total Risk
<i>*Secular Equilibrium Risk for Am-241</i>	-	-	6.27E-06	<b>6.27E-06</b>
<i>*Secular Equilibrium Risk for Co-60</i>	-	-	1.02E-06	<b>1.02E-06</b>
<i>*Secular Equilibrium Risk for Cs-137</i>	-	-	6.54E-07	<b>6.54E-07</b>
<i>*Secular Equilibrium Risk for Eu-152</i>	-	-	1.60E-06	<b>1.60E-06</b>
<i>*Secular Equilibrium Risk for Eu-154</i>	-	-	3.07E-06	<b>3.07E-06</b>
<i>*Secular Equilibrium Risk for H-3</i>	-	-	-	-
<i>*Secular Equilibrium Risk for Pu-239</i>	-	-	1.38E-05	<b>1.38E-05</b>
<i>*Secular Equilibrium Risk for Ra-226</i>	-	-	1.91E-05	<b>1.91E-05</b>
<i>*Secular Equilibrium Risk for Sr-90</i>	-	-	1.47E-08	<b>1.47E-08</b>
<i>*Secular Equilibrium Risk for Th-232</i>	-	-	4.39E-05	<b>4.39E-05</b>
<i>*Secular Equilibrium Risk for U-235</i>	-	-	1.04E-06	<b>1.04E-06</b>
<i>*Total Risk</i>	-	-	9.05E-05	<b>9.05E-05</b>